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(12) UK Patent Application (19) GB (11) 2 257 552 (13) A

(43) Date of A publication 13.01.1993

(21) Application No 9212015.3

(22) Date of filing 05.06.1992

(30) Priority data
(31) 91A000435 (32) 07.06.1991 (33) IT

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(51) INT CL5
G08C 23/00, B60R 25/00, G07C 9/00

(52) UK CL (Edition L)
G4H HRBE HRCC HRCE HTG H1A H13D H14A
H14B H14D H60
U1S S1820 S1856

(56) Documents cited
GB 2254461 A GB 2131992 A GB 1595797 A
GB 1595796 A US 4686529 A

(58) Field of search
UK CL (Edition K) G4H HRBE HRBS HRCE HRCS
HTG
INT CL5 B60R, G07C, G08C

(54) **Extra-safe remote control**

(57) A remote control uses a recognition code which consists of a fixed portion and a portion varying with time. The time code is generated simultaneously by a counter (7) in the transmitter (2) and a counter (30) in the receiver (3), both counters being synchronized with each other at the customization stage and subsequent to each operation of the remote control. The recognition code transmitted is thus correlated at all times with the instant in which the code is transmitted, and so varies with time for safeguarding against unlawful entry by copying the recognition code.

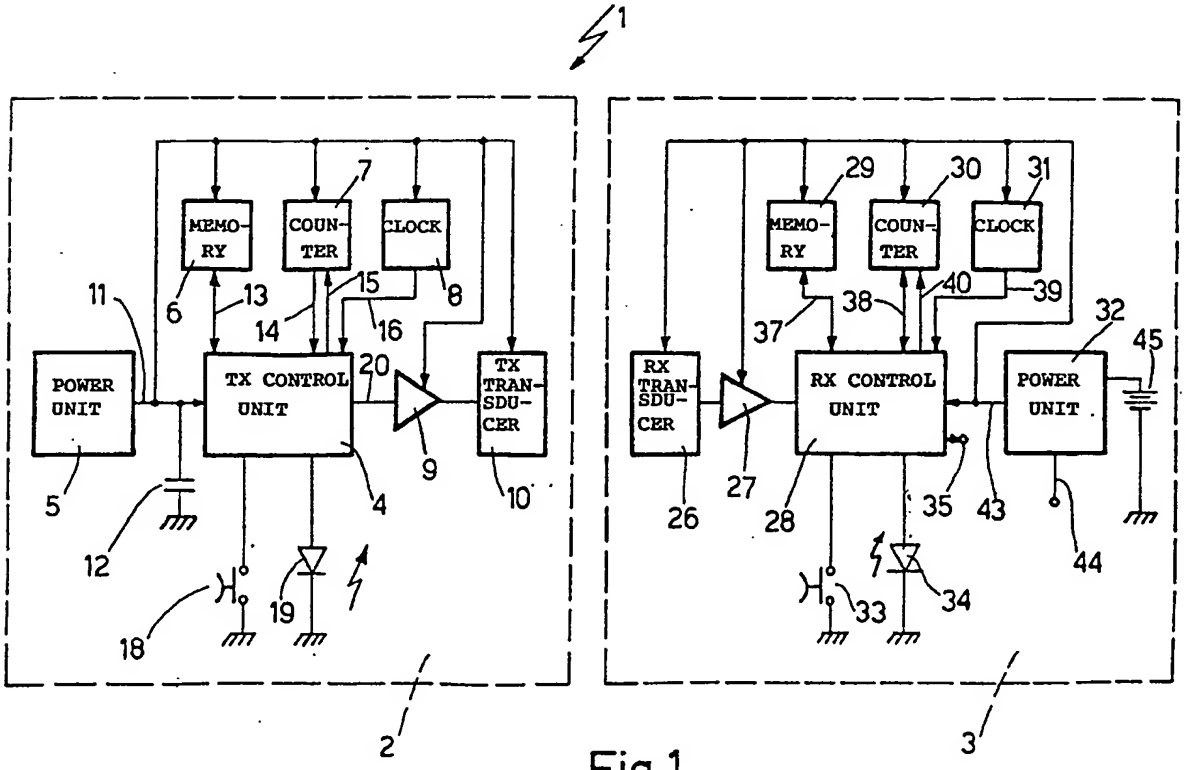

Fig.1

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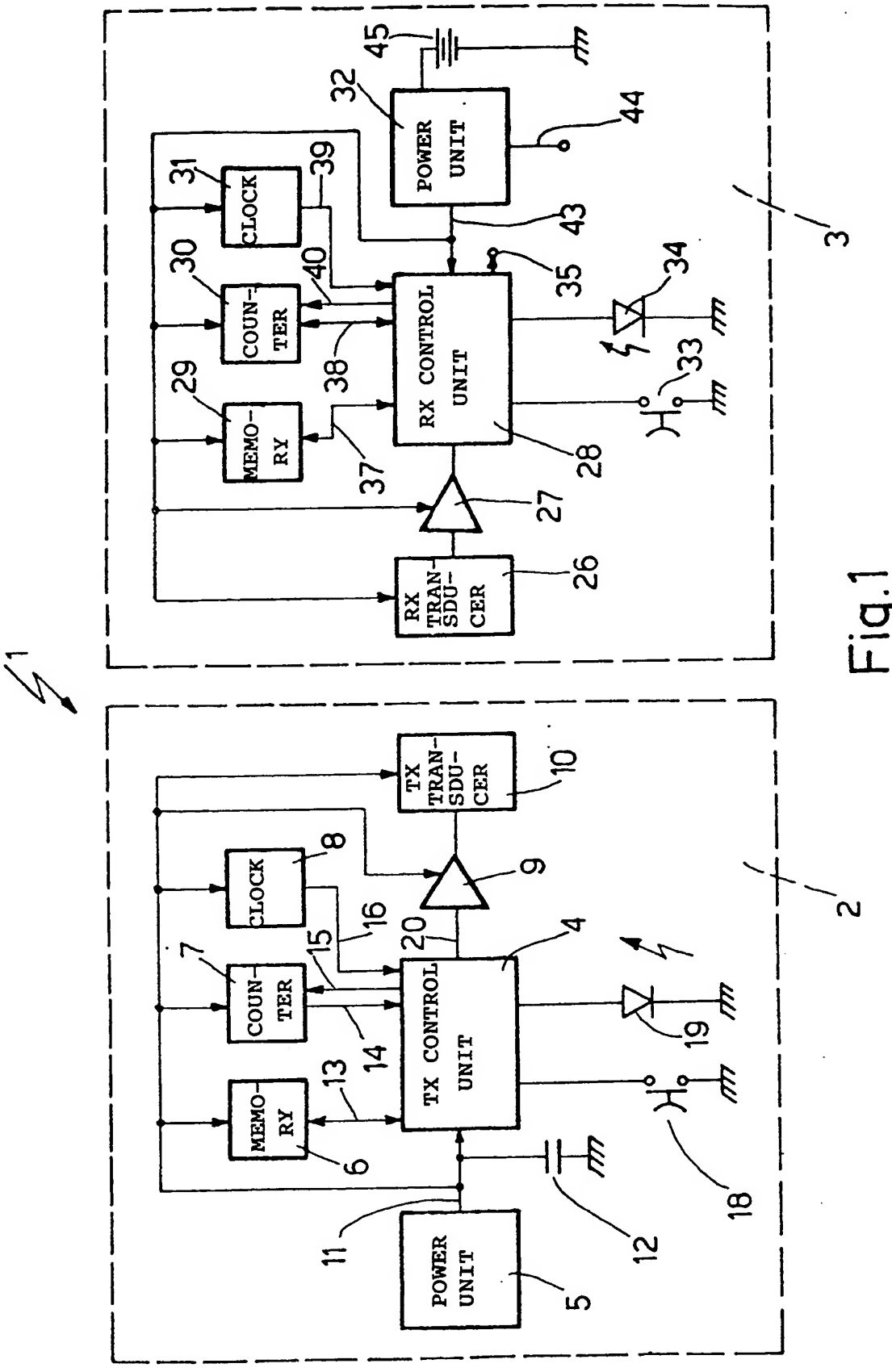
1
2
3
TX TRANSDUCER
10
CLOCK
8
9
COUNTER
7
MEMORY
6
TX CONTROL UNIT
4
POWER UNIT
5
11
12
13
14
15
16
18
19
20
RX TRANSDUCER
26
27
RX CONTROL UNIT
28
MEMORY
29
COUNTER
30
CLOCK
31
POWER UNIT
32
33
34
35
37
38
39
40
43
44
45

Fig.1

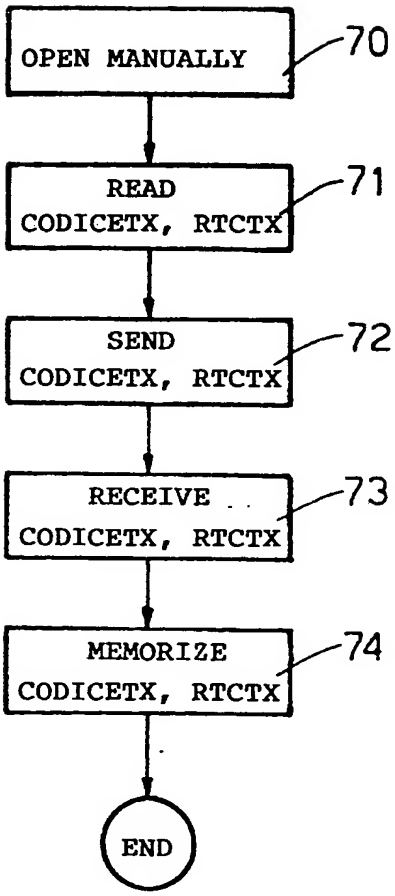

Fig.5

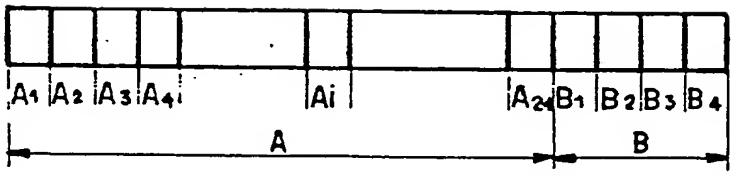

Fig.2

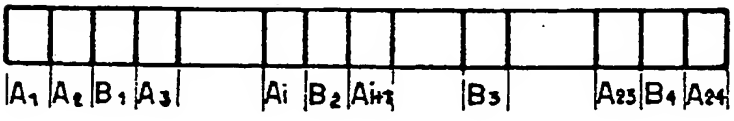

Fig.3

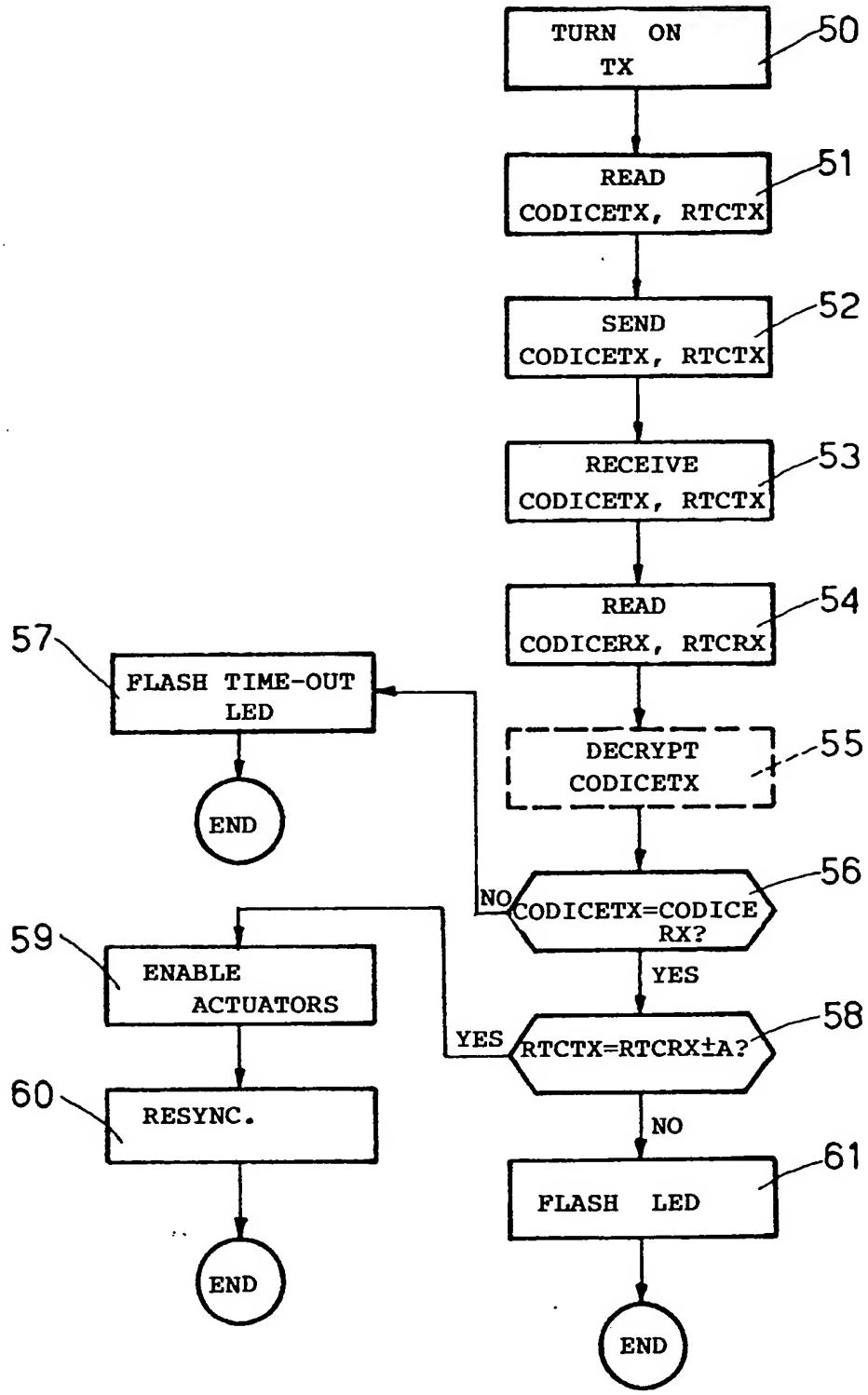
TURN ON TX
50
READ CODICETX, RTCTX
51
SEND CODICETX, RTCTX
52
RECEIVE CODICETX, RTCTX
53
READ CODICERX, RTCRX
54
DECRYPT CODICETX
55
CODICETX=CODICE RX?
56
NO
YES
RTCTX=RTCRX±A?
58
YES
NO
FLASH LED
61
END
57
FLASH TIME-OUT LED
END
59
ENABLE ACTUATORS
60
RESYNC.
END

Fig.4

EXTRA-SAFE REMOTE CONTROL

The present invention relates to an extra-safe remote control.

Known remote controls comprise a transmitting element for supplying a recognition code to a receiver connected to an actuating element fitted, for example, to a vehicle for enabling centralized control of the vehicle doors.

The remote controls dealt with in the following description are those enabling modification of the memorized code, using an electrically erasable programmable read only memory (EEPROM), and whereby the code is transmitted to the receiver via infrared pulses.

A major drawback of known remote controls of the aforementioned type is the possibility of unauthorized copies being made of the recognition code using automatic code copiers originally designed for other uses (specifically for combining in one control all the codes governing various home appliances, such as televisions, video recorders, compact disk readers, etc.) and which provide for memorizing the code as it is

transmitted, and for subsequently producing and retransmitting a copy. Consequently, when applied to recognition codes governing the actuator of a vehicle door release mechanism, such copiers enable the vehicle doors to be opened at any time, even without the original remote control.

Nor can such a system be combatted by simply modifying the code, using encryption systems or by varying the electric characteristics of the code pulses, as these too would simply be reproduced by the copier.

It is an object of the present invention to provide a remote control designed to overcome the aforementioned drawback, i.e. which provides for improved protection against forcible entry by copying the recognition code.

According to the present invention, there is provided an extra-safe remote control, particularly for controlling a vehicle-mounted actuating element, said control comprising a transmitter having transmission transducer means for transmitting a recognition code; and a receiver having receiving transducer means for receiving said recognition code, and means for generating an enabling output signal in the event of the incoming recognition code substantially matching a reference code; characterized by the fact that said transmitter and said receiver comprise respective means for generating a time code varying with time.

According to the present invention, there is also provided a method for remote control of an actuating element, said method comprising stages consisting in: transmitting a recognition code, receiving said recognition code, comparing the incoming recognition code with a reference code, and generating an enabling signal in the event of said incoming recognition code substantially matching said reference code; characterized by the fact that said recognition code transmitting stage comprises stages consisting in: generating a time code varying with time, and transmitting said time code; and said stage wherein said incoming recognition code is compared with said reference code comprises stages consisting in: generating a reference time code varying with time, and comparing said incoming time code with said reference time code.

In other words, according to the present invention, any copies made of the recognition code using currently employed copiers are rendered ineffective, by virtue of the memorized copy relating to the first transmission of the code, when the copy is made, and failing to evolve dynamically with the time code generated in the receiver. Consequently, the memorized copy of the code is not recognized by the receiver, which thus fails to emit the enabling output signal.

A preferred, non-limiting embodiment of the present invention will be described by way of example with reference to the accompanying drawings, in which:

Fig.1 shows a simplified block diagram of the remote control according to the present invention;

Fig.2 shows a schematic diagram of the recognition code according to the present invention;

Fig.3 shows a variation of the Fig.2 recognition code;

Fig.s 4 and 5 show two simplified flow charts of the enabling method according to the present invention.

Number 1 in Fig.1 indicates a remote control consisting, in known manner, of a transmitter 2 and a receiver 3. More specifically, transmitter 2 comprises a control unit 4, a power supply unit 5, a non-volatile memory 6, a counter 7, a clock 8, an amplifier 9, and a transmission transducer 10.

Power unit 5, which includes a replaceable battery (not shown), provides for generating at output 11 the supply voltage for operating the various components of transmitter 2, output 11 being connected to a capacitor 12 for maintaining supply to transmitter 2 over a brief period and so enabling replacement of the battery with no loss of data. Memory 6, e.g. an EEPROM, is connected to control unit 4 over a two-way line 13, and provides for memorizing the recognition code of remote control 1, which may be modified as described in Italian Patents 1.183.797 and 1.196.831 filed respectively on 4.4.85 and

10.12.86 by Turatti Mario. Counter 7, which is connected to control unit 4 over one-way outgoing and incoming lines 14 and 15, provides for generating a time code (supplied over line 14) evolving with time according to a predetermined law, on the basis of increment pulses supplied by control unit 4 over line 15 and in turn generated by control unit 4 at predetermined intervals on the basis of sync pulses supplied to control unit 4 by clock 8 over line 16.

Control unit 4 is also connected to a hand switch 18 for operating transmitter 2 and emitting the recognition code, and to a LED 19 for indicating the operating mode of transmitter 2. The code supply output of control unit 4 is connected over line 20 to the input of amplifier 9, which drives transducer 10 for emitting the pulses, e.g. infrared pulses, relative to the single binary digits of the code.

Receiver 3 comprises a receiving transducer 26 output-connected to the input of an amplifier 27 in turn output-connected to a receiving control unit 28 also connected to a memory 29, a counter 30, a clock 31, a power supply unit 32, a hand switch 33, and a LED 34. Control unit 28 also presents an output 35 connected to the actuating device being controlled (not shown).

More specifically, memory 29, connected to control unit 28 over a two-way line 37, provides for memorizing the fixed though user-variable portion (identification code) of the recognition code, and preferably consists

of an EEPROM. Counter 30, connected to control unit 28 over a two-way line 38, provides for generating the variable time code, corresponding to the time code generated by counter 7 of transmitter 2, on the basis of pulses generated by clock 31 and supplied to control unit 28 over a one-way outgoing line 39. In this case also, counter 30 is incremented by control unit 28 over a one-way outgoing line 40 to counter 30, while the time code is exchanged between counter 30 and control unit 28 over line 38, as explained in more detail later on.

Power supply unit 32, which supplies the various components of receiver 3 over line 43 and is in turn supplied at input 44 by the vehicle battery (not shown), is connected to a rechargeable buffer battery 45 capable of powering the receiver and updating the counter over a period of months, even in the event of the vehicle battery being disconnected or running down.

The transmitter and receiver are first synchronized alongside customization of the receiver, which is effected in known manner (as described, for example, in the above patents filed by Turatti Mario), and provides for entering the same identification code and the same start value of the counter (time code) in both parts of the control. In actual use, counters 7 and 30 of transmitter 2 and receiver 3 evolve in the same way, incrementing by one unit at predetermined time intervals (e.g. every 10 seconds) on the basis of the pulses generated by respective control units 4 and 28.

Any inaccuracy of clocks 8 and 31 (detected when testing the control) may be compensated by control units 4 and 28 via software, in the same way as for digital clocks, for achieving a high degree of precision in the timing of the increment pulses.

Despite varying with time, the content of counter 7 is therefore equal at all times to that of counter 30, and may thus be employed for enabling receiver 3 to recognize the associated transmitter. More specifically, whenever it is turned on, the transmitter supplies the recognition code valid at that particular time and consisting of both the fixed identification code (in memory 6) and the time code (counter 7) varying according to when the transmitter is turned on.

Fig.s 2 and 3 show two examples of the code transmitted. In the Fig.2 example, the code consists of two sequentially transmitted parts: fixed identification code portion A, and time code portion B. In this particular case, the identification code comprises 24 binary digits (A1-A24) followed by four binary time code digits (B1-B4), the advantage of which solution is that it can also be applied to conventional type receivers using only the first fixed portion digits and ignoring the rest. In the Fig.3 example, on the other hand, the time code digits (B1-B4) are mixed with the fixed identification code digits (A1-A24) for achieving greater code protection. The time code digits may be located differently from one code to another, thus

providing for a sort of cryptosystem, in which case, the recognition code may also comprise further decryption key digits.

Under correct operating conditions, the incoming code to receiver 3 matches the reference code, so that an enabling signal is supplied to output 35 for enabling the actuator. Conversely, if the incoming code fails to match the reference code, even if only as regards the time code, the transmitter is considered invalid, and the enabling signal is not supplied. In other words, even if the recognition code is memorized correctly at a given time using an automatic code copier, it is subsequently rendered ineffective by failing to evolve in the manner identified by the receiver.

Recognition of the time code by receiver 3 preferably allows of a small amount of error by acknowledging time codes within a predetermined range in relation to the nominal value. Moreover, in the event of the time code being acknowledged, the receiver writes the incoming time code over that supplied by counter 30, so as to reset the timing error each time (resynchronization). In any case, provision is made for manually resynchronizing the receiver in the event of a loss of synchronism in relation to the transmitter, e.g. due to prolonged disconnection or discharge of the vehicle battery over and above the supply capacity of buffer battery 45, or prolonged disconnection or discharge of the transmitter battery. Obviously, manual

resynchronization of the receiver involves a special procedure for maintaining security of the remote control.

Operation relative to transmission and recognition of the code and resynchronization of the receiver will now be described in detail with reference to Fig.s 4 and 5.

The Fig.4 flow chart shows the operating sequence as of when the transmitter is turned on by the user pressing key 18 (block 50). When the transmitter is turned on, control unit 4 reads the identification code (CODICETX) stored in memory 6, and the current content of counter 7 (RTCTX) (block 51), and generates the actual recognition code according to the required code structure, possibly also encrypting the code or the fixed portion of it and adding a number of decrypting key digits. The recognition code is then supplied to amplifier 9 and transducer 10 by which it is modulated in known manner and transmitted in the form of infrared pulses (block 52).

The transmitted recognition code is received by receiving transducer 26 and, after being amplified, is supplied to control unit 28 of receiver 3 (block 53), which in turn reads the reference identification code stored in memory 29 (CODICERX), and the current content of counter 30 (RTCRX) (block 54); if necessary, decrypts the incoming identification code CODICETX (block 55); and compares the two identification codes CODICETX and

CODICERX (block 56). If the two codes fail to match (NO output of block 56), the actuator remains disabled, and control unit 28 supplies LED 34, which flashes briefly to indicate an error in the identification code (block 57), which thus marks the end of the procedure.

Conversely, if the two identification codes are found to match (YES output of block 56), control unit 28 compares the incoming time code RTCTX with the reference time code RTCRX plus or minus a given error A (block 58), and, if the incoming time code falls within the tolerance range of the receiver (YES output of block 58), enables the actuator (block 59) and rememorizes the incoming time code RTCTX in counter 30, which is resynchronized to said value (block 60), thus marking the end of the procedure.

In the event of the two time codes failing to match within the given tolerance range (NO output of block 58), control unit 28 provides for supplying LED 34, which flashes to show acknowledgement of the identification code, but an error in the time code (block 61). The procedure therefore terminates without enabling the actuator, thus preventing unlawful entry by transmitting a recognition code copied and therefore set to a previous instant in time. Should the time code fail to be acknowledged due to a loss of synchronism between the transmitter and receiver, this must be resynchronized manually as shown in detail in Fig.5.

The first stage in the resynchronizing procedure consists in manually opening the receiver (block 70) in the same way as for entering fixed identification codes on user-variable-code transmitters (as described, for example, in the aforementioned patents filed by Turatti Mario). To open the receiver, the user, by means of key 33, enters the code supplied with the remote control (e.g. the encrypted identification code printed on the transmitter label), and then turns on the remote control, at which point, control unit 4 (block 71) reads the identification code CODICETX and time code RTCTX, as described in connection with block 51 in Fig.4. Both codes are composed as already described, and transmitted via pulses (block 72). Receiver 3 receives the incoming pulses (block 73) and stores the incoming identification code CODICETX and time code RTCTX (decrypted if necessary) in memory 29 and counter 30 respectively (block 74), thus resynchronizing the transmitter and receiver (the identification code is rememorized by virtue of the procedure also providing for modifying the identification code in known manner).

The advantages of the remote control and the remote control method according to the present invention will be clear from the foregoing description. By virtue of transmitting both a transmitter identification code and a transmission time code, the present invention provides for safeguarding the receiver against

unauthorized control, and so achieving a high degree of security of the remote control as a whole.

Security is even further enhanced by encrypting the recognition code, either traditionally by encrypting the fixed identification code or time code, or by mixing the fixed and time code digits, or by varying the manner in which the time code evolves, thus making unlawful entry highly unlikely, even in the event of attempts to update the copied time code.

Automatic resynchronization of the receiver and transmitter each time the recognition code is matched (in addition to software correction of the clock frequency) provides for counteracting possible drift of either one of the clocks, while the manual resynchronizing procedure enables the system to be re-initialized by the user, for further confounding unauthorized users.

Yet a further advantage is the provision of short-term supply systems for supplying the transmitter and receiver in the event of disconnection or discharge of the respective batteries, so that the remote control need not be resynchronized each time the transmitter battery is changed or the vehicle battery runs down.

To those skilled in the art it will be clear that changes may be made to the remote control and method described and illustrated herein without, however, departing from the scope of the present invention. For example, the time code may evolve in any manner

providing it is correlated on both the transmitter and receiver; the overall recognition code may be encrypted in various ways as already suggested; and the receiver may comprise a number of storage locations and counters (or one storage location with different transformations or various encryptions for producing various fixed identification codes, and/or one counter with different transformations for producing various time codes) for recognizing a number of transmitters associated with the same receiver, in which case, each memory and each counter are independent and can be modified separately.

CLAIMS

1) An extra-safe remote control (1), particularly for controlling a vehicle-mounted actuating element, said control (1) comprising a transmitter (2) having transmission transducer means (10) for transmitting a recognition code; and a receiver (3) having receiving transducer means (26) for receiving said recognition code, and means (28, 58) for generating an enabling output signal (35) in the event of the incoming recognition code substantially matching a reference code; characterized by the fact that said transmitter (2) and said receiver (3) comprise respective means (7, 30) for generating a time code varying with time.

2) A remote control as claimed in Claim 1, characterized by the fact that said generating means respectively comprise at least one transmission and receiving counter (7, 30) having an input (15, 40) for receiving increment pulses, and an output (14, 38) for supplying a variable number correlated to said increment pulses.

3) A remote control as claimed in Claim 2, characterized by the fact that said transmitter (2) and said receiver (3) respectively comprise at least one transmission and receiving memory (6, 29) for storing a fixed identification code.

4) A remote control as claimed in Claim 3, characterized by the fact that said transmitter (2)

comprises a transmission control unit (4) connected to said transmission counter (7), to said transmission memory (6), and to an operating key (18); said transmission control unit (4) comprising means (50) for detecting operation of said key (18); means (51) for reading said identification code in said transmission memory (6) and said time code in said transmission counter (7); and means (52) for generating a predetermined transmission sequence from said identification and time codes.

5) A remote control as claimed in Claim 4, characterized by the fact that said transmission transducer means (10) comprise means for sequentially transmitting infrared pulses.

6) A remote control as claimed in Claim 4 or 5, characterized by the fact that said receiver (3) comprises a receiving control unit (28) connected to said receiving counter (30), to said receiving memory (29), and to said receiving transducer means (26); said receiving control unit (28) comprising means (56, 58) for comparing the incoming identification code with the content of said receiving memory (29), and the incoming time code with the content of said receiving counter (30), and for generating said enabling signal in the event of both matching.

7) A remote control as claimed in Claim 6, characterized by the fact that said receiving control unit (28) comprises means (60) for writing said incoming

time code in said receiving counter (30) subsequent to generation of said enabling signal.

8) A remote control as claimed in Claim 6 or 7, characterized by the fact that said receiver (3) comprises a key (33) for updating said recognition code.

9) A remote control as claimed in one of the foregoing Claims from 3 to 8, characterized by the fact that said memories (6, 29) are EEPROMs.

10) A remote control as claimed in one of the foregoing Claims from 1 to 9, characterized by the fact that said transmitter (2) comprises a supply stage (5) having a supply output (11) connected to a capacitor (12).

11) A remote control as claimed in one of the foregoing Claims from 1 to 10, characterized by the fact that said receiver (3) comprises a supply stage (32) supplied externally via a main supply input (44) and having an auxiliary supply input connected to a buffer battery (45).

12) A remote control as claimed in one of the foregoing Claims from 6 to 11, characterized by the fact that said receiving control unit (28) is connected to a light-emitting element (34) for indicating acknowledgement of said identification code only.

13) A method for remote control of an actuating element, said method comprising stages consisting in: transmitting (51, 52) a recognition code, receiving (53) said recognition code, comparing (54, 56, 58) the

incoming recognition code with a reference code, and generating (59) an enabling signal in the event of said incoming recognition code substantially matching said reference code; characterized by the fact that said recognition code transmitting stage comprises stages consisting in: generating (51) a time code varying with time, and transmitting (52) said time code; and said stage wherein said incoming recognition code is compared with said reference code comprises stages consisting in: generating (54) a reference time code varying with time, and comparing (58) said incoming time code with said reference time code.

14) A method as claimed in Claim 13, characterized by the fact that said stages consisting in generating (51) a time code and generating (54) a reference time code comprise stages consisting in memorizing and periodically incrementing an initial value.

15) A method as claimed in Claim 14, characterized by the fact that said enabling signal is generated in the event of said incoming time code matching said reference time code within a given error range.

16) A method as claimed in one of the foregoing Claims from 13 to 15, characterized by the fact that said stage consisting in transmitting said recognition code also comprises a further stage consisting in reading (51) a fixed identification code, and transmitting (52) said identification code together with said time code; and by the fact that said stage

consisting in comparing said incoming recognition code with said reference code also comprises a further stage consisting in reading (54) a fixed reference identification code, and comparing (56) said reference identification code with said incoming identification code.

17) A method as claimed in Claim 16, characterized by the fact that it comprises stages consisting in: detecting (50) operation of an operating key (18); reading (51) said identification code and said time code; and generating (52) a predetermined transmission sequence from said identification and time codes.

18) A method as claimed in Claim 17, characterized by the fact that said identification code and said time code are transmitted consecutively.

19) A method as claimed in Claim 17, characterized by the fact that the digits of said identification code and said time code are transmitted mixed in a predetermined manner.

20) A method as claimed in one of the foregoing Claims from 17 to 19, characterized by the fact that said identification code is encrypted prior to transmission, and decrypted (55) prior to being compared with said reference identification code.

21) A method as claimed in one of the foregoing Claims from 13 to 17, characterized by the fact that said recognition code is transmitted via infrared pulses.

22) A method as claimed in one of the foregoing Claims from 16 to 21, characterized by the fact that, subsequent to generation (59) of said enabling signal, the incoming time code is written (60) over said reference time code.

23) A method as claimed in one of the foregoing Claims from 16 to 22, characterized by the fact that a predetermined light signal is generated (57) upon detection (56) of matching identification codes but mismatching time codes.

24) A recognition code transmitted between the transmitter and receiver of a remote control, in particular, for controlling an actuating element, characterized by the fact that it comprises a time code (B) varying with time, for coding the instant in which transmission is effected.

25) A code as claimed in Claim 24, characterized by the fact that it also comprises a fixed portion defining an identification code (A) not varying with time.

26) A code as claimed in Claim 24 or 25, characterized by the fact that it is transmitted in the form of a sequence of infrared pulses.

27) An extra-safe remote control, method for remote control of an actuating element, and recognition code, substantially as described and illustrated herein with reference to the accompanying drawings.

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Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number
GB 9212015.3

Relevant Technical fields

(i) UK Cl (Edition K) G4H (HTG HRBE HRBS HRCE HRCS)

(ii) Int Cl (Edition 5) B60R G07C G08C

Search Examiner
M J DAVIS

Databases (see over)

(i) UK Patent Office

(ii)

Date of Search
9 OCTOBER 1992

Documents considered relevant following a search in respect of claims 1-27

Category (see over)	Identity of document and relevant passages		Relevant to claim(s)
X E	GB 2254461 A	(ALPS ELECTRIC) whole document	1, 13, 24 at least
X	GB 2131992 A	(KIEKERT) whole document	1-27
X	GB 1595797	(PUSHMAN) whole document, especially page 3 lines 10-37	1-27
X	GB 1595796	(PUSHMAN) whole document, especially page 5 lines 93-121	1-27
X	US 4686529	(KLEEFELDT) whole document	1-27

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

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P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family, corresponding document.

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